

Claims

- [c1] A method of forming a buried dielectric collar around a trench, comprising:
 - (a) forming said trench in a substrate;
 - (b) forming a multilayer coating on sidewalls and a bottom of said trench;
 - (c) removing a continuous band of said multilayer coating from said sidewalls a fixed distance from a top of said trench to expose a continuous band of substrate in said sidewalls of said trench;
 - (d) etching, in said exposed band of substrate, a lateral trench extending into said substrate in said sidewalls of said trench; and
 - (e) filling said lateral trench with a dielectric material to form said buried dielectric collar.
- [c2] The method of claim 1, wherein said buried dielectric collar extends continuously around said trench.
- [c3] The method of claim 1, wherein said buried dielectric collar extends into said trench.
- [c4] The method of claim 1, wherein step (c) comprises;
defining a top edge of said band with a first recessed re-

sist process; and

defining a bottom edge of said band with a second re-
cessed resist process.

[c5] The method of claim 1, wherein said multilayer coating comprises in order from said substrate outward, a layer of silicon oxide, a first layer of silicon nitride, a layer of polysilicon and a second layer of silicon nitride.

[c6] The method of step (e) wherein said substrate includes silicon and said dielectric material is silicon oxide formed by oxidation of said substrate.

[c7] A method of forming a trench capacitor, comprising:
(a) forming a trench in a substrate;
(b) forming a multilayer coating on sidewalls and a bot-
tom of said trench;
(c) removing a continuous band of said multilayer coat-
ing from said sidewalls a fixed distance from a top of
said trench to expose a continuous band of substrate in
said sidewalls of said trench;
(d) etching, in said exposed band of substrate, a lateral
trench extending into said substrate in said sidewalls of
said trench;
(e) filling said lateral trench with a dielectric material to
form said buried dielectric collar;
(f) filling said trench with polysilicon.

- [c8] The method of claim 7, wherein said buried dielectric collar extends continuously around said trench.
- [c9] The method of claim 7, wherein said buried dielectric collar extends into said trench.
- [c10] The method of claim 7, wherein step (c) comprises;
defining a top edge of said band with a first recessed resist process; and
defining a bottom edge of said band with a second recessed resist process.
- [c11] The method of claim 7, wherein said multilayer coating comprises in order from said substrate outward, a layer of silicon oxide, a first layer of silicon nitride, a layer of polysilicon and a second layer of silicon nitride.
- [c12] The method of step (e) wherein said substrate includes silicon, said dielectric material is silicon oxide formed by oxidation of said substrate.
- [c13] The method of claim 7, further including between steps (e) and (f):
removing remaining multilayer coating from said trench;
and
forming at least one dielectric layer on said sidewalls and bottom of said trench.

[c14] The method of claim 7, further including between steps (e) and (f):

removing remaining multilayer coating from a portion of said bottom of said trench;

etching said substrate to form an extension of said trench deeper into said substrate; and

forming at least one dielectric layer on said sidewalls and bottom of said extension of said trench.

[c15] A method of forming a buried dielectric collar around a trench, comprising:

(a) forming said trench in silicon substrate;

(b) forming a multilayer coating on sidewalls and a bottom of said trench, said multilayer coating comprises in order from said substrate outward, a layer of silicon oxide, a first layer of silicon nitride, a layer of polysilicon and a second layer of silicon nitride;

(c) forming a first resist fill a first distance from a top of said trench;

(e) removing said first silicon nitride layer not protected by said first resist fill exposing a upper portion of said polysilicon layer and oxidizing an outer layer of said upper portion of said polysilicon layer to form a second silicon oxide layer on said polysilicon layer and then removing said first resist fill;

(f) forming a second resist fill a second distance from a

top of said trench, said second distance being greater than said first distance;

(g) removing in the order recited, (i) between said second silicon oxide layer and a top surface of said second fill resist, a continuous band of said second silicon nitride layer, a continuous band of said polysilicon layer, a continuous band of said first silicon nitride layer and a continuous band of said first silicon oxide layer to expose a continuous band of substrate in said sidewalls of said trench and said second resist fill or (ii) between said second silicon oxide layer and a top surface of said second fill resist, a continuous band of said second silicon nitride layer, a continuous band of said polysilicon layer and a continuous band of said first silicon nitride layer and then removing said second fill resist and said first silicon oxide layer to expose a continuous band of substrate in said sidewalls of said trench;

(h) etching, in said exposed band of substrate, a lateral trench extending into said substrate in said sidewalls of said trench; and

(i) filling said lateral trench with a dielectric material to form said buried dielectric collar.

[c16] The method of claim 15, wherein in step (g) said second resist fill is removed prior to removing said first silicon oxide layer.

- [c17] The method of claim 15, wherein said buried dielectric collar extends continuously around said trench.
- [c18] The method of claim 15, wherein said buried dielectric collar extends into said trench.
- [c19] The method of claim 15, further including:
 - (j) forming a third silicon nitride layer over all exposed surfaces of all, remaining layers on said sidewalls, said bottom of said trench and over portion of said buried dielectric collar in said lateral trench exposed in said trench; and
 - (k) forming a third silicon oxide layer over said third silicon dielectric layer.
- [c20] The method of claim 15, wherein exposed portions of said polysilicon layer adjacent to said lateral trench are removed when said lateral trench is formed and are filled with silicon oxide when said buried dielectric collar is formed.